BIBLIOGRAPHIC NOTE ON SUNSHINE IN THE UNITED STATES.

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In view of the fact that a forthcoming section of the Atlas of American Agriculture will contain a series of new sunshine charts for the United States, it may not be inappropriate to give a brief bibliographic note on the sunshine charts for this country which have been published up to the present time. As the new charts will, to a large extent, supersede the older ones, no detailed descriptions and no reproductions of any of the latter are here included.

Sunshine is the complement of cloudiness. The relation is simple: the more cloud, the less sunshine, and vice versa. If, therefore, the mean monthly or mean annual percentages of cloudiness be subtracted from 100, the remainders should give the amounts of sunshine in percentages of the possible duration. Similarly, if the possible duration of sunshine (in percentages) be subtracted from 100, the remainder should give the mean cloudiness. These results are, however, only approximate.* They may, and often do, differ more or less from the instrumental results obtained by means of sunshine recorders. The amount of cloudiness is based upon estimates, made by eye at certain stated hours during the day. Such estimates are inevitably more or less inaccurate and individual, and are difficult to make when the clouds are near the horizon. Sunshine recorders, on the other hand, while they give a rigidly instrumental record of the duration of bright sunshine, include only a small portion of the sky, and are also less reliable when the sun is low, and its rays are weak. These intrinsic sources of inaccuracy do not, however, in any way seriously interfere with the value of the ordinary sunshine data which are available for many parts of the world.

Sunshine charts are of two classes. They either give (1) the number of hours of bright sunshine, as determined by means of sunshine recorders; or they show (2) the duration of sunshine in percentages of the possible duration. These percentages may be obtained from the cloudiness, as above noted, or by comparing the total number of hours of bright sunshine as indicated by sunshine recorders with the total possible number of hours, and expressing the results as percentages. When eye observations of cloudiness are available, but sufficient instrumental records of sunshine are lacking, the former method is the one naturally adopted. Sunshine charts of both of the above kinds have been published for the United States.

To the first group belong the chart of mean annual sunshine of North America published by van Bebber in 1896,[1] and a series of charts published by Glaser in 1912.[2] Van Bebber's map, well known because of its having been included in Bartholomew's Atlas of Meteorology, is based upon data collected up to the end of 1895, chiefly those of photographic sunshine recorders and of differential thermometers. The available material was confessedly very inadequate. The maximum number of hours of bright sunshine is given as 3,250, in the southwestern interior. From that area there is a decrease in all directions, especially toward the north and northwest. The line of 2,000 hours runs fairly closely along the northern border of the United States. All the lines are broadly generalized and have mostly an east-west course. Gläser's study of cloudiness and sunshine is by far the most complete which has hitherto appeared in print. His charts show the mean duration of sunshine (in hours) for each month and for the year, and in hours of the day for each month. Records were used for 62 stations with ordinary and for 28 stations with photographic recorders. The chart of mean annual duration of sunshine in hours is based on more complete data than were available when van Bebber's map was prepared. Gläser's map gives more detail, and emphasizes local conditions. The maximum number of hours of bright sunshine (3,500) is found in Arizona and the adjacent portions of southwestern Utah and southeastern Nevada. From here the decrease is marked to the northwest, north, and northeast, and, to a less degree, to the east. The smallest number of hours is below 2,000 on the extreme northwestern coast, and in the northeast, especially over the Great Lakes. The number of hours of bright sunshine, by months, shows a well-defined general increase all over the country from December to July. There is, in other words, a general northward migration of summer conditions as the season advances from winter to mid-summer, summer having the maximum sunshine in most sections, although spring and autumn are the sunniest seasons over small areas. At most stations, also, December has the smallest number of sunny hours and July has the largest. The annual variation in the amounts of sunshine is greatest in the northwest and over the Lake region.

Charts of the second group, viz., those showing the duration of sunshine in percentages of the possible duration, have been prepared by the U. S. Weather Bureau, and, more recently, also by Gläser. In 1898 Prof. A. J. Henry published the first map of normal annual sunshine for the United States.[3]

The percentages of sunshine were obtained by subtracting the mean annual cloudiness from 100. A later table, published in 1906, gave, for varying periods of time, the percentages of sunshine derived from the records of automatically-recording instruments at a number of selected stations.[4] Sunshine recorders began to be installed at Weather Bureau stations in the early nineties, and now practically all stations are provided with these instruments.

A later map of normal annual sunshine, compiled from observations at Weather Bureau stations from 1871 to 1908, inclusive, was published as one of a series of climatic charts issued by the Weather Bureau. This map, also, seems to have been based upon the values obtained by subtracting the mean annual cloudiness from 100. In Gläser's monograph, above referred to, there are included charts showing the isohels for each month and for the year, the percentages being based upon instrumental records. These published charts of mean annual sunshine do not differ much from one another. The highest percentage of sunshine (over 80 per cent) is in the extreme southwestern interior. The minimum amounts (40 per cent) are found on the North Pacific coast, and over portions of the Lake Region and of the extreme northeast. Most of the country has not far from 50 per cent. The maps and tables published by the Weather Bureau, together with the monthly, seasonal and other mapsand diagrams prepared by Gläser, have thus brought together a large amount of information concerning sunshine in the United States.

* For instance with the sky "cloudy" with cirro-stratus bright sunshine may be recorded for hours.—ED.

[1] W. J. van Bebber: "Die Sonnenscheindauer in Europe und Nordamerika," *Natur und Offenbarung*, Vol. 42, Münster, 1896, pp. 705-716, with map. Reproduced in *Atlas of Meteorology*. Pl. 18; text, p. 17.

[2] Arthur Gläser: "Bewölkungsverhältnisse und Sonnenscheindauer von Nordamerika," *Archiv. der Deutschen Seewarte*, Vol. 35, 1912, No. 1, 4to pp. 66; pls. 7; figs. 22.

[3] Alfred J. Henry: "Normal Annual Sunshine and Snowfall," *Mo. Wea. Rev.*, Vol. 26, 1898, p. 108, with map (Chart X) and table giving the annual percentages of sunshine by calendar years for each of the regular Weather Bureau and Canadian stations.

[4] Alfred J. Henry: "Climatology of the United States," *Bulletin Q*. U. S. Weather Bureau, 4to. Washington, D. C., 1906. Table IX, p. 110; text p. 65.

The essential facts are these: The north has less sunshine than the south. The west has on the whole more sunshine than the east. The southwest is the sunniest; the northwest and northeast are the least sunny. East of the Rocky Mountains there is less difference between north and south than to the west of the continental divide. There is less contrast between north and south on the Atlantic than on the Pacific coast. The west coast has the advantage in regard to sunshine as far north as latitude 40° N.; from there northwards, the conditions are reversed. Winter is as a whole distinctly the least, and summer the most sunny season.

Many interesting comparisons suggest themselves as regards sunshine between Europe and the United States, but this consideration is not an appropriate part of the present bibliographic note. It may, however, be interesting to add that the contrast between western Europe and eastern North America was clearly emphasized by Woeikof a number of years ago.[5] He pointed out that the American coast has great advantages in respect to sunshine, especially if stations having similar temperatures and not stations in the same latitudes are considered. "Not only is the duration of sunshine longer (on the American coast) but the air is clearer, especially in the colder months. This contrast is very strikingly emphasized on the voyage from England to the United States."

A NEW INSTRUMENT FOR MEASURING SKY RADIATION.

By Dr. ANDERS ÅNGSTRÖM.

[Dated: Meteorclogical Bureau, Stockholm, Sweden, October, 1919.]

The idea of comparing the heat produced or lost at a certain surface by radiation with the heat produced through an electrical current in order to balance the named gain or loss of heat has shown itself most fruitful in the construction of instruments for cosmical radiation measurements. Thus after the electrical compensation pyrheliometer was constructed in 1893 by K. Ångström,[1] the same principle was used by him in 1905[2] in order to determine the so-called nocturnal radiation, and now recently by Abbot and Aldrich,[3] attempting to measure the intensity of the diffused daylight by an ingeniously modified type of the compensation pyrheliometer.

A fairly good idea having been obtained of solar radiation and its variations, the last-named problem is at present one of the most important in actinometry and certainly also in meteorology in general. At high latitudes the heat transferred to the surface of the earth through luminous radiation from the sky, viz, through diffused sun radiation, must, on the average, amount to about 40 per cent of the total heat income from sun and sky together, and in the artic regions this source of heat and light is during the winter time the most important one.

In the following, I will give a description of a new instrument for measuring luminous-sky radiation founded upon the method of electrical compensation. The instrument may be used also for measuring the radiation of the sun and it may easily, in proper combination, be used as a self-recording instrument.

The construction is schematically shown by figure 1 (A, B, and C). It is in its main features very similar to the construction of the nocturnal radiation actinometer (the pyrgeometer). The bright strips of the pyrgeometer are, however, here replaced by strips that first are blackened with platinum black and afterwards covered with magnesium oxide to proper thickness. *aa* and *bb* in figure 1 (A and C) show the white and black strips, respectively, mounted on a hard-rubber frame in the end of a nickel-plated tube. Thermo-electric junctions are provided at the back of the strips, but electrically insulated from them. These junctions may be connected

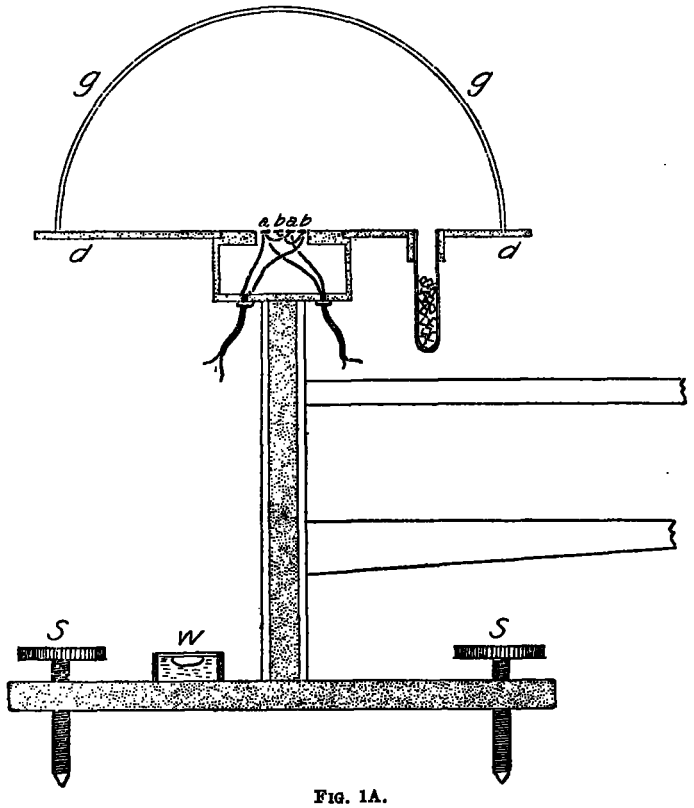

FIG. 1A.

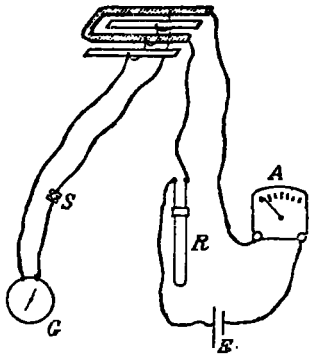

Fig. 1B

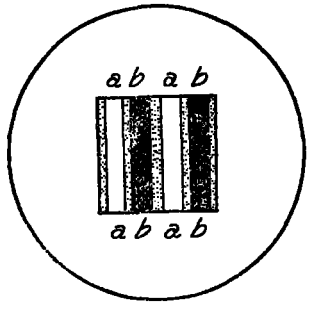

FIG. 1C.

in a circuit that also includes a delicate galvanometer G (fig. 1 B). To the tube and in the same plane with the strips is attached a circular metal disk *dd*, which acts as a support for the hemispherical glass screen *gg*, covering the strips, the purpose of which will be explained below. The metal disk is covered on its upper side by white paper, which is a better reflector for short wave radiation than the bright metal. On the supporting metal disk can also be placed a cylindrical metal cover in order to exclude the instrument from radiation from sun and sky. Through the water-level *w* and the two leveling screws *s* the hori-

[5] A. Woeikof: "Die Klimate der Erde" Jena, 1887, Part II, p. 45.
[1] K. Ångström: Nova Acta Upsal., 1893.
[2] K. Ångström: Nova Acta Upsal., 1905.
[3] Abbott and Aldrich: Smithsonian Misc. Coll., 66, Nos. 7 and 11.